

---

### **UNIT TERMINAL OBJECTIVE**

- 2-1 At the completion of this unit, the paramedic student will be able to establish and/ or maintain a patent airway, oxygenate, and ventilate a patient.

### **COGNITIVE OBJECTIVES**

At the completion of this unit, the paramedic student will be able to:

- 2-1.1 Explain the primary objective of airway maintenance. (C-1)
- 2-1.2 Identify commonly neglected prehospital skills related to airway. (C-1)
- 2-1.3 Identify the anatomy of the upper and lower airway. (C-1)
- 2-1.4 Describe the functions of the upper and lower airway. (C-1)
- 2-1.5 Explain the differences between adult and pediatric airway anatomy. (C-1)
- 2-1.6 Define gag reflex. (C-1)
- 2-1.7 Explain the relationship between pulmonary circulation and respiration. (C-3)
- 2-1.8 List the concentration of gases that comprise atmospheric air. (C-1)
- 2-1.9 Describe the measurement of oxygen in the blood. (C-1)
- 2-1.10 Describe the measurement of carbon dioxide in the blood. (C-1)
- 2-1.11 Describe peak expiratory flow. (C-1)
- 2-1.12 List factors that cause decreased oxygen concentrations in the blood. (C-1)
- 2-1.13 List the factors that increase and decrease carbon dioxide production in the body. (C-1)
- 2-1.14 Define atelectasis. (C-1)
- 2-1.15 Define FiO<sub>2</sub>. (C-1)
- 2-1.16 Define and differentiate between hypoxia and hypoxemia. (C-1)
- 2-1.17 Describe the voluntary and involuntary regulation of respiration. (C-1)
- 2-1.18 Describe the modified forms of respiration. (C-1)
- 2-1.19 Define normal respiratory rates and tidal volumes for the adult, child, and infant. (C-1)
- 2-1.20 List the factors that affect respiratory rate and depth. (C-1)
- 2-1.21 Explain the risk of infection to EMS providers associated with ventilation. (C-3)
- 2-1.22 Define pulsus paradoxes. (C-1)
- 2-1.23 Define and explain the implications of partial airway obstruction with good and poor air exchange. (C-1)
- 2-1.24 Define complete airway obstruction. (C-1)
- 2-1.25 Describe causes of upper airway obstruction. (C-1)
- 2-1.26 Describe causes of respiratory distress. (C-1)
- 2-1.27 Describe manual airway maneuvers. (C-1)
- 2-1.28 Describe the Sellick (cricoid pressure) maneuver. (C-1)
- 2-1.29 Describe complete airway obstruction maneuvers. (C-1)
- 2-1.30 Explain the purpose for suctioning the upper airway. (C-1)
- 2-1.31 Identify types of suction equipment. (C-1)
- 2-1.32 Describe the indications for suctioning the upper airway. (C-3)
- 2-1.33 Identify types of suction catheters, including hard or rigid catheters and soft catheters. (C-1)
- 2-1.34 Identify techniques of suctioning the upper airway. (C-1)
- 2-1.35 Identify special considerations of suctioning the upper airway. (C-1)
- 2-1.36 Describe the indications, contraindications, advantages, disadvantages, complications, equipment and technique of tracheobronchial suctioning in the intubated patient. (C-3)
- 2-1.37 Describe the use of an oral and nasal airway. (C-1)
- 2-1.38 Identify special considerations of tracheobronchial suctioning in the intubated patient. (C-1)
- 2-1.39 Define gastric distention. (C-1)
- 2-1.40 Describe the indications, contraindications, advantages, disadvantages, complications, equipment and

- technique for inserting a nasogastric tube and orogastric tube. (C-1)
- 2-1.41 Identify special considerations of gastric decompression. (C-1)
- 2-1.42 Describe the indications, contraindications, advantages, disadvantages, complications, and technique for inserting an oropharyngeal and nasopharyngeal airway (C-1)
- 2-1.43 Describe the indications, contraindications, advantages, disadvantages, complications, and technique for ventilating a patient by: (C-1)
1. Mouth-to-mouth
  2. Mouth-to-nose
  3. Mouth-to-mask
  4. One person bag-valve-mask
  5. Two person bag-valve-mask
  6. Three person bag-valve-mask
  7. Flow-restricted, oxygen-powered ventilation device
- 2-1.44 Explain the advantage of the two person method when ventilating with the bag-valve-mask. (C-1)
- 2-1.45 Compare the ventilation techniques used for an adult patient to those used for pediatric patients. (C-3)
- 2-1.46 Describe indications, contraindications, advantages, disadvantages, complications, and technique for ventilating a patient with an automatic transport ventilator (ATV). (C-1)
- 2-1.47 Explain safety considerations of oxygen storage and delivery. (C-1)
- 2-1.48 Identify types of oxygen cylinders and pressure regulators (including a high-pressure regulator and a therapy regulator). (C-1)
- 2-1.49 List the steps for delivering oxygen from a cylinder and regulator. (C-1)
- 2-1.50 Describe the use, advantages and disadvantages of an oxygen humidifier. (C-1)
- 2-1.51 Describe the indications, contraindications, advantages, disadvantages, complications, liter flow range, and concentration of delivered oxygen for supplemental oxygen delivery devices. (C-3)
- 2-1.52 Define, identify and describe a tracheostomy, stoma, and tracheostomy tube. (C-1)
- 2-1.53 Define, identify, and describe a laryngectomy. (C-1)
- 2-1.54 Define how to ventilate with a patient with a stoma, including mouth-to-stoma and bag-valve-mask-to-stoma ventilation. (C-1)
- 2-1.55 Describe the special considerations in airway management and ventilation for patients with facial injuries. (C-1)
- 2-1.56 Describe the special considerations in airway management and ventilation for the pediatric patient. (C-1)
- 2-1.57 Differentiate endotracheal intubation from other methods of advanced airway management. (C-3)
- 2-1.58 Describe the indications, contraindications, advantages, disadvantages and complications of endotracheal intubation. (C-1)
- 2-1.59 Describe laryngoscopy for the removal of a foreign body airway obstruction. (C-1)
- 2-1.60 Describe the indications, contraindications, advantages, disadvantages, complications, equipment, and technique for direct laryngoscopy. (C-1)
- 2-1.61 Describe visual landmarks for direct laryngoscopy. (C-1)
- 2-1.62 Describe use of cricoid pressure during intubation. (C-1)
- [2-1.63 Describe indications, contraindications, advantages, disadvantages, complications, equipment and technique for digital endotracheal intubation. \(C-1\)](#)
- 2-1.64 Describe the indications, contraindications, advantages, disadvantages, complications, equipment and technique for using a dual lumen airway. (C-3)
- [2-1.65 Describe the indications, contraindications, advantages, disadvantages, complications and equipment for](#)

- [rapid sequence intubation with neuromuscular blockade. \(C-1\)](#)
- 2-1.66 [Identify neuromuscular blocking drugs and other agents used in rapid sequence intubation. \(C-1\)](#)
- 2-1.67 [Describe the indications, contraindications, advantages, disadvantages, complications and equipment for sedation during intubation. \(C-1\)](#)
- 2-1.68 [Identify sedative agents used in airway management. \(C-1\)](#)
- 2-1.69 Describe the indications, contraindications, advantages, disadvantages, complications, equipment and technique for nasotracheal intubation. (C-1)
- 2-1.70 Describe the indications, contraindications, advantages, disadvantages and complications for performing an open cricothyrotomy. (C-3)
- 2-1.71 [Describe the equipment and technique for performing an open cricothyrotomy. \(C-1\)](#)
- 2-1.72 Describe the indications, contraindications, advantages, disadvantages, complications, equipment and technique for transthyroglottal catheter ventilation (needle cricothyrotomy). (C-3)
- 2-1.73 Describe methods of assessment for confirming correct placement of an endotracheal tube. (C-1)
- 2-1.74 Describe methods for securing an endotracheal tube. (C-1)
- 2-1.75 Describe the indications, contraindications, advantages, disadvantages, complications, equipment and technique for extubation. (C-1)
- 2-1.76 Describe methods of endotracheal intubation in the pediatric patient. (C-1)

### **AFFECTIVE OBJECTIVES**

At the completion of this unit, the paramedic student will be able to:

- 2-1.77 Defend the need to oxygenate and ventilate a patient. (A-1)
- 2-1.78 Defend the necessity of establishing and/ or maintaining patency of a patient's airway. (A-1)
- 2-1.79 Comply with standard precautions to defend against infectious and communicable diseases. (A-1)

### **PSYCHOMOTOR OBJECTIVES**

At the completion of this unit, the paramedic student will be able to:

- 2-1.80 Perform body substance isolation (BSI) procedures during basic airway management, advanced airway management, and ventilation. (P-2)
- 2-1.81 Perform pulse oximetry. (P-2)
- 2-1.82 Perform end-tidal CO<sub>2</sub> detection. (P-2)
- 2-1.83 Perform peak expiratory flow testing. (P-2)
- 2-1.84 Perform manual airway maneuvers, including: (P-2)
- a. Opening the mouth
  - b. Head-tilt/ chin-lift maneuver
  - c. Jaw-thrust without head-tilt maneuver
  - d. Modified jaw-thrust maneuver
- 2-1.85 Perform manual airway maneuvers for pediatric patients, including: (P-2)
- a. Opening the mouth
  - b. Head-tilt/ chin-lift maneuver
  - c. Jaw-thrust without head-tilt maneuver
  - d. Modified jaw-thrust maneuver
- 2-1.86 Perform the Sellick maneuver (cricoid pressure). (P-2)
- 2-1.87 Perform complete airway obstruction maneuvers, including: (P-2)
- a. Heimlich maneuver
  2. Finger sweep
  3. Chest thrusts

4. Removal with Magill forceps
- 2-1.88 Demonstrate suctioning the upper airway by selecting a suction device, catheter and technique. (P-2)
- 2-1.89 Perform tracheobronchial suctioning in the intubated patient by selecting a suction device, catheter and technique. (P-2)
- 2-1.90 Demonstrate insertion of a nasogastric tube. (P-2)
- 2-1.91 Demonstrate insertion of an orogastric tube. (P-2)
- 2-1.92 Perform gastric decompression by selecting a suction device, catheter and technique. (P-2)
- 2-1.93 Demonstrate insertion of an oropharyngeal airway. (P-2)
- 2-1.94 Demonstrate insertion of a nasopharyngeal airway. (P-2)
- 2-1.95 Demonstrate ventilating a patient by the following techniques: (P-2)
  - a. Mouth-to-mask ventilation
  2. One person bag-valve-mask
  3. Two person bag-valve-mask
  4. Three person bag-valve-mask
  5. Flow-restricted, oxygen-powered ventilation device
  6. Automatic transport ventilator
  7. Mouth-to-stoma
  8. Bag-valve-mask-to-stoma ventilation
- 2-1.96 Ventilate a pediatric patient using the one and two person techniques. (P-2)
- 2-1.97 Perform ventilation with a bag-valve-mask with an in-line small-volume nebulizer. (P-2)
- 2-1.98 Perform oxygen delivery from a cylinder and regulator with an oxygen delivery device. (P-2)
- 2-1.99 Perform oxygen delivery with an oxygen humidifier. (P-2)
- 2-1.100 Deliver supplemental oxygen to a breathing patient using the following devices: nasal cannula, simple face mask, partial rebreather mask, non-rebreather mask, and venturi mask (P-2)
- 2-1.101 Perform stoma suctioning. (P-2)
- 2-1.102 Perform retrieval of foreign bodies from the upper airway. (P-2)
- 2-1.103 Perform assessment to confirm correct placement of the endotracheal tube. (P-2)
- 2-1.104 Intubate the trachea by the following methods: (P-2)
  - a. Orotracheal intubation
  - b. Nasotracheal intubation
  - c. Multi-lumen airways
  9. Digital intubation
  - d. Transillumination
  - e. Open cricothyrotomy
- 2-1.105 Adequately secure an endotracheal tube. (P-1)
- 2-1.106 Perform endotracheal intubation in the pediatric patient. (P-2)
- 2-1.107 Perform transtracheal catheter ventilation (needle cricothyrotomy). (P-2)
- 2-1.108 Perform extubation. (P-2)
- 2-1.109 Perform replacement of a tracheostomy tube through a stoma. (P-2)

---

## DECLARATIVE

- I. Introduction
  1. The body's need for oxygen
  2. Primary objective of emergency care
    - a. Ensure optimal ventilation
      - (1) Delivery of oxygen
      - (2) Elimination of CO<sub>2</sub>
  3. Brain death occurs within 6 to 10 minutes
  4. Major prehospital causes of preventable death
    - a. Early detection
    - b. Early intervention
    - c. Lay-person BLS education
  5. Most often neglected of prehospital skills
    - a. Basics taken for granted
    - b. Poor techniques
      - (1) BVM seal
      - (2) Improper positioning
      - (3) Failure to reassess
- II. Anatomy of upper airway
  1. Function of the upper airway
    - a. Warm
    - b. Filter
    - c. Humidify
  2. Pharynx
    - a. Nasopharynx
      - (1) Formed by the union of facial bones
      - (2) Orientation of nasal floor is towards the ear not the eye
      - (3) Separated by septum
      - (4) Lined with
        - (a) Mucous membranes
        - (b) Cilia
      - (5) Turbinate
        - (a) Parallel to nasal floor
        - (b) Provide increased surface area for air
          - i) Filtration
          - ii) Humidifying
          - iii) Warming
      - (6) Sinuses
        - (a) Cavities formed by cranial bones
        - (b) Appear to further trap bacteria and act as tributaries for fluid to and from Eustachian tubes and tear ducts
          - i) Commonly become infected
          - ii) Fracture of certain sinus bones may cause cerebrospinal fluid (CSF) leak
      - (7) Tissues extremely delicate and vascular
        - (a) Improper or overly aggressive placement of tubes or airways will cause significant bleeding which may not be controlled by direct pressure

- b. Oropharynx
  - (1) Teeth
    - (a) 32 adult
    - (b) Requires significant force to dislodge
    - (c) May fracture or avulse causing obstruction
  - (2) Tongue
    - (a) Large muscle attached at the mandible and hyoid bones
    - (b) Most common airway obstruction
  - (3) Palate
    - (a) Roof of mouth separates oro/ nasopharynx
      - i) Anterior is hard palate
      - ii) Posterior (beyond the teeth) is soft palate
  - (4) Adenoids
    - (a) Lymph tissue located in the mouth and nose that filters bacteria
    - (b) Frequently infected and swollen
  - (5) Posterior tongue
  - (6) Epiglottis
  - (7) Vallecula
    - (a) "Pocket" formed by the base of the tongue and epiglottis
    - (b) Important landmark for endotracheal intubation
- 3. Larynx
  - a. Attached to hyoid bone
    - (1) "Horseshoe-shaped" bone between the chin and mandibular angle
    - (2) Supports trachea
    - (3) Made of cartilage
  - b. Thyroid cartilage
    - (1) First tracheal cartilage
    - (2) "Shield-shaped"
      - (a) Cartilage anterior
      - (b) Smooth muscle posterior
    - (3) Laryngeal prominence
      - (a) "Adam's Apple" anterior prominence of thyroid cartilage
      - (b) Glottic opening directly behind
  - c. Glottic opening
    - (1) Narrowest part of adult trachea
    - (2) Patency heavily dependent on muscle tone
    - (3) Contain vocal bands
      - (a) White bands of cartilage
      - (b) Produce voice
  - d. Arytenoid cartilage
    - (1) "Pyramid-like" posterior attachment of vocal bands
    - (2) Important landmark for endotracheal intubation
  - e. Pyriform fossae
    - (1) "Hollow pockets" along the lateral borders of the larynx
  - f. Cricoid ring
    - (1) First tracheal ring
    - (2) Completely cartilaginous
    - (3) Compression occludes esophagus (Sellick maneuver)
  - g. Cricothyroid membrane

- (1) Fibrous membrane between cricoid and thyroid cartilage
    - (2) Site for surgical and alternative airway placement
  - h. Associated structures
    - (1) Thyroid gland
      - (a) Located below cricoid cartilage
      - (b) Lies across trachea and up both sides
    - (2) Carotid arteries
      - (a) Branches cross and lie closely alongside trachea
    - (3) Jugular veins
      - (a) Branch across and lie close to trachea
- III. Anatomy of lower airway
  - 1. Function of the lower airway
    - a. Exchange of O<sub>2</sub> and CO<sub>2</sub>
  - 2. Location of the lower airway
    - a. From fourth cervical vertebrae to xiphoid process
    - b. From glottic opening to pulmonary capillary membrane
  - 3. Structures of the lower airway
    - a. Trachea
      - (1) Trachea bifurcates at carina into
        - (a) Right and left mainstem bronchi
        - (b) Right mainstem has lesser angle
          - i) Foreign bodies, ET tubes commonly displace here
      - (2) Lined with
        - (a) Mucous cells
        - (b) Beta 2 receptors - dilate bronchioles
    - b. Bronchi
      - (1) Mainstem bronchi enter lungs at hilum
      - (2) Branch into narrowing secondary and tertiary bronchi that branch into bronchioles
    - c. Bronchioles
      - (1) Branch into alveolar ducts that end at alveolar sacs
    - d. Alveoli
      - (1) "Balloon-like" clusters
      - (2) Site of gas exchange
      - (3) Lined with surfactant
        - (a) Decreases surface tension of alveoli which facilitates ease of expansion
        - (b) Alveoli become thinner as they expand which makes diffusion of O<sub>2</sub>/ CO<sub>2</sub> easier
        - (c) If surfactant is decreased or alveoli are not inflated, alveoli collapse (atelectasis)
    - e. Lungs
      - (1) Right lung
        - (a) 3 lobes
      - (2) Left lung
        - (a) 2 lobes
      - (3) Lobes made of parenchymal tissue
      - (4) Membranous outer lining called pleura
      - (5) Lung capacity
- IV. Differences in pediatric airway
  - 1. Pharynx

- a. A proportionately smaller jaw causes the tongue to encroach upon the airway
- b. Omega shaped, floppy epiglottis
- c. Absent or very delicate dentition
- 2. Trachea
  - a. Airway is smaller and narrower at all levels
  - b. Larynx lies more superior
  - c. Larynx is "funnel-shaped" due to narrow, undeveloped cricoid cartilage
  - d. Narrowest point is at cricoid ring before 10 years of age
  - e. Further narrowing of the airway by tissue swelling of foreign body results in major increase in airway resistance
- 3. Chest wall
  - a. Ribs and cartilage are softer
  - b. Cannot optimally contribute to lung expansion
  - c. Infants and children tend to depend more heavily on the diaphragm for breathing
- V. Lung/ respiratory volumes
- 1. Total lung volume
  - a. Adult male, 6 liters
  - b. Not all inspired air enters alveoli
  - c. Minor diffusion of O<sub>2</sub> takes place in alveolar ducts and terminal bronchioles
- 2. Tidal volume
  - a. Volume of gas inhaled or exhaled during a single respiratory cycle
  - b. 5-7cc/ kg (500 cc normally)
- 3. Dead space air
  - a. Air remaining in air passageways, unavailable for gas exchange (approximately 150cc)
  - b. Anatomic dead space
    - (1) Trachea
    - (2) Bronchi
  - c. Physiologic dead space
    - (1) Dead space formed by factors like disease or obstruction
      - (a) COPD
      - (b) Atelectasis
- 4. Minute volume
  - a. Amount of gas moved in and out of the respiratory tract per minute
  - b. Determined by
    - (1) Tidal volume - dead space volume times respiratory rate
- 5. Functional reserve capacity
  - a. After optimal inspiration: optimum amount of air that can be forced from the lungs in a single exhalation
- 6. Residual volume
  - a. Volume of air remaining in lungs at the end of maximal expiration
- 7. Alveolar air
  - a. Air reaching the alveoli for gas exchange (alveolar volume)
  - b. Approximately 350 cc
- 8. Inspiratory reserve
  - a. Amount of gas that can be inspired in addition to tidal volume
- 9. Expiratory reserve
  - a. Amount of gas that can be expired after a passive (relaxed) expiration
- 10. FiO<sub>2</sub>



- a. Percentage of oxygen in inspired air (increases with supplemental oxygen)
  - (1) Commonly documented as a decimal (e.g.,  $\text{FiO}_2 = .85$ )

VI. Ventilation

1. Definition - movement of air into and out of the lungs

2. Phases

- a. Inspiration
  - (1) Stimulus to breathe from respiratory center
  - (2) Impulse transmitted to diaphragm via phrenic nerve
    - (a) Diaphragm - "muscle of respiration"
    - (b) Separates thoracic from abdominal cavity
  - (3) Diaphragm contracts - "flattens"
    - (a) Causes intrapulmonic pressure to fall slightly below atmospheric pressure
  - (4) Intercostal muscles contract
  - (5) Ribs elevate and expand
  - (6) Air is drawn into lungs like a vacuum
  - (7) Alveoli Inflate
  - (8)  $\text{O}_2$ /  $\text{CO}_2$  are able to diffuse across membrane
- b. Expiration
  - (1) Stretch receptors in lungs signal respiratory center via vagus nerve to inhibit inspiration (Hering-Breuer Reflex)
  - (2) Natural elasticity (recoil) of the lungs passively expires air

VII. Respiration

1. Definition

- a. Exchange of gases between a living organism and its environment
- b. The major gases of respiration are oxygen and carbon dioxide

2. Types

- a. External respiration - exchange of gasses between the lungs and the blood cells
- b. Internal respiration - exchange of gases between the blood cells and tissues

3. The transportation of oxygen and carbon dioxide in the human body

- a. Diffusion - passage of solution from area of higher concentration to lower concentration
  - (1)  $\text{O}_2$ /  $\text{CO}_2$  dissolve in water and pass through alveolar membrane by diffusion
- b. Oxygen content of blood
  - (1) Dissolved  $\text{O}_2$  crosses pulmonary capillary membrane and binds to hemoglobin (Hgb) of red blood cell
  - (2) Oxygen is carried
    - (a) Bound to hemoglobin
    - (b) Dissolved in plasma
  - (3) Approximately 97% of total  $\text{O}_2$  is bound to hemoglobin
  - (4)  $\text{O}_2$  saturation
    - (a) % of hemoglobin saturated
    - (b) Normally greater than 98%
- c. Oxygen in the blood
  - (1) Bound to hemoglobin
    - (a)  $\text{SaO}_2$
  - (2) Dissolved in plasma
    - (a)  $\text{PaO}_2$
- d. Carbon dioxide content of the blood

- (1) CO<sub>2</sub> is a byproduct of cellular work (cellular respiration)
    - (2) CO<sub>2</sub> is transported in blood as bicarbonate ion
    - (3) About 33% is bound to hemoglobin
    - (4) As O<sub>2</sub> crosses into blood, CO<sub>2</sub> diffuses into alveoli
    - (5) Carbon dioxide in the blood
      - (a) PaCO<sub>2</sub>
  - e. Diagnostic testing
    - (1) Pulse oximetry
    - (2) Peak expiratory flow testing
    - (3) End-tidal CO<sub>2</sub> monitoring
    - (4) Other equipment
- VIII. Causes of decreased oxygen concentrations in the blood
  - 1. Lower partial pressure of atmospheric O<sub>2</sub>
  - 2. Lower hemoglobin levels in blood
  - 3. Trauma
    - a. Less surface area for gas exchange
      - (1) Pneumothorax
      - (2) Hemothorax
      - (3) Combination of pneumothorax and hemothorax
    - b. Decreased mechanical effort
      - (1) Pain
      - (2) Traumatic suffocation
      - (3) Hypoventilation
  - 4. Medical
    - a. Physiological barriers
      - (1) Pneumonia
      - (2) Pulmonary edema
      - (3) COPD
- IX. Carbon dioxide in blood
  - 1. Increases
    - a. Hypoventilation
  - 2. Decreases
    - a. Hyperventilation
- X. The measurement of gases
  - 1. Total pressure
    - a. The combined pressure of all atmospheric gases
    - b. 100% or 760 torr at sea level
  - 2. Partial pressure
    - a. The pressure exerted by a specific atmospheric gas
  - 3. Concentration of gases in the atmosphere
    - a. Nitrogen 597.0 torr (78.62%)
    - b. Oxygen 159.0 torr (20.84%)
    - c. CO<sub>2</sub> 0.3 torr ( 0.04%)
    - d. Water 3.7 torr ( 0.5%)
  - 4. Water vapor pressure
  - 5. Alveolar gas concentration

- a. Nitrogen 569.0 torr (74.9%)
- b. Oxygen 104.0 torr (13.7%)
- c. CO<sub>2</sub> 40.0 torr ( 5.2%)
- d. Water 47.0 torr ( 6.2%)

XI. Respiratory rate

- 1. Definition - the number of times a person breathes in one minute
- 2. Neural control
  - a. Primary control from the medulla and pons
  - b. Medulla
    - (1) Primary involuntary respiratory center
    - (2) Connected to respiratory muscles by vagus nerve
  - c. Pons
    - (1) Apneustic center - secondary control center if medulla fails to initiate respiration
    - (2) Pneumotaxic center - controls expiration
- 3. Chemical stimuli
  - a. Receptors for O<sub>2</sub>/ CO<sub>2</sub> balance
    - (1) Cerebrospinal fluid pH
    - (2) Carotid bodies (sinus)
    - (3) Aortic arch
  - b. Hypoxic drive - respiratory stimulus dependent on O<sub>2</sub> rather than CO<sub>2</sub> in the blood
- 4. Control of respiration by other factors
  - a. Body temperature - respirations increase with fever
  - b. Drug and medications - may increase or decrease respirations depending on their physiologic action
  - c. Pain - increases respirations
  - d. Emotion - increases respirations
  - e. Hypoxia - increases respirations
  - f. Acidosis - respirations increase as compensatory response to increased CO<sub>2</sub> production
  - g. Sleep - respirations decrease

XII. Pathophysiology

- 1. Obstruction
  - a. Tongue
    - (1) Most common airway obstruction
    - (2) Snoring respirations
    - (3) Corrected with positioning
  - b. Foreign body
    - (1) May cause partial or full obstruction
    - (2) Symptoms include
      - (a) Choking
      - (b) Gagging
      - (c) Stridor
      - (d) Dyspnea
      - (e) Aphonia (unable to speak)
      - (f) Dysphonia (difficulty speaking)
  - c. Laryngeal spasm and edema
    - (1) Spasm
      - (a) Spasmodic closure of vocal cords

- (b) Most frequently caused by
      - i) Trauma from over aggressive technique during intubation
      - ii) Immediately upon extubation especially when patient is semiconscious
  - (2) Edema
    - (a) Glottic opening becomes extremely narrow or totally obstructed
    - (b) Most frequently caused by
      - i) Epiglottitis (a bacterial infection of the epiglottis)
      - ii) Anaphylaxis (severe allergic reaction)
      - iii) Relieved by
    - (c) Aggressive ventilation
    - (d) Forceful upward pull of the jaw
    - (e) Muscle relaxants
- d. Fractured larynx
  - (1) Airway patency dependent upon muscle tone
  - (2) Fractured laryngeal tissue
    - (a) Increases airway resistance by decreasing airway size through
      - i) Decreasing muscle tone
      - ii) Laryngeal edema
      - iii) Ventilatory effort
- e. Aspiration
  - (1) Significantly increases mortality
    - (a) Obstructs airway
    - (b) Destroys delicate bronchiolar tissue
    - (c) Introduces pathogens
    - (d) Decreases ability to ventilate

XIII. Airway evaluation

1. Essential parameters

- a. Rate
  - (1) Normal resting rate in adults - 12-24
- b. Regularity
  - (1) Steady pattern
  - (2) Irregular respiratory patterns are significant until proven otherwise
- c. Effort
  - (1) Breathing at rest should be effortless
  - (2) Effort changes may be subtle in rate or regularity
  - (3) Patients often compensate by preferential positioning
    - i) Upright sniffing
    - ii) Semifowlers
    - iii) Frequently avoid supine

2. Recognition of airway problems

- a. Respiratory distress
  - (1) Upper and lower airway obstruction
  - (2) Inadequate ventilation
  - (3) Impairment of the respiratory muscles
  - (4) Impairment of the nervous system
- b. Difficulty in rate, regularity, or effort is defined as dyspnea
- c. Dyspnea may be result of or result in hypoxia
  - (1) Hypoxia - lack of oxygen

- (2) Hypoxia - lack of oxygen to tissues
  - (3) Anoxia - total absence of oxygen
- d. Recognition and treatment of dyspnea is crucial to patient survival
  - (1) Expert assessment and management is essential
    - (a) The brain can survive only a few minutes of anoxia
    - (b) All therapies fail if airway is inadequate
- e. Visual techniques
  - (1) Position
    - (a) Tripod positioning
    - (b) Orthopnea
  - (2) Rise and fall of chest
  - (3) Gasping
  - (4) Color of skin
  - (5) Flaring of nares
  - (6) Pursed lips
  - (7) Retraction
    - (a) Intercostal
    - (b) Suprasternal notch
    - (c) Supraclavicular fossa
    - (d) Subcostal
- f. Auscultation techniques
  - (1) Air movement at mouth and nose
  - (2) Bilateral lung fields equal
- g. Palpation Techniques
  - (1) Air movement at mouth and nose
  - (2) Chest wall
    - (a) Paradoxical motion
    - (b) Retractions
- h. Bag-valve-mask
  - (1) Resistance or changing compliance with bag-valve-mask ventilations
- i. Pulsus paradoxus
  - (1) Systolic blood pressure drops greater than 10mm Hg with inspiration
    - (a) Change in pulse quality maybe detected
    - (b) Seen in COPD, pericardial tamponade
    - (c) Possible increase in intrathoracic pressure
- j. History
  - (1) Evolution
    - (a) Sudden
    - (b) Gradual over time
    - (c) Known cause or "trigger"
  - (2) Duration
    - (a) Constant
    - (b) Recurrent
  - (3) Ease - what makes it better?
  - (4) Exacerbate - what makes it worse?
  - (5) Associate
    - (a) Other symptoms (productive cough, chest pain, fever, etc...)
  - (6) Interventions
    - (a) Evaluations/ admissions to hospital

- (b) Medications (include compliance)
      - (c) Ever intubated
    - k. Modified forms of respiration
      - (1) Protective reflexes
        - (a) Cough
          - i) Forceful, spastic exhalation
          - ii) Aids in clearing bronchi and bronchioles
        - (b) Sneeze - clears nasopharynx
        - (c) Gag reflex - spastic pharyngeal and esophageal reflex from stimulus of the posterior pharynx
      - (2) Sighing
        - (a) Involuntary deep breath that increases opening of alveoli
        - (b) Normally sigh about once per minute
      - (3) Hiccough - intermittent spastic closure of glottis
  - l. Respiratory pattern changes
    - (1) Cheyne-Stokes
      - (a) Gradually increasing rate and tidal volume followed by gradual decrease
      - (b) Associated with brain stem insult
    - (2) Kussmaul's breathing
      - (a) Deep, gasping respirations
      - (b) Common in diabetic coma
    - (3) Biot's respirations
      - (a) Irregular pattern, rate, and volume with intermittent periods of apnea
      - (b) Increased intracranial pressure
    - (4) Central neurogenic hyperventilation
      - (a) Deep rapid respirations similar to Kussmaul's
      - (b) Increased intracranial pressure
    - (5) Agonal
      - (a) Slow, shallow, irregular respirations
      - (b) Resulting from brain anoxia
  - m. Inadequate ventilation
    - (1) Occurs when body cannot compensate for increased O<sub>2</sub> demand or maintain O<sub>2</sub>/ CO<sub>2</sub> balance
    - (2) Many causes
      - (a) Infection
      - (b) Trauma
      - (c) Brainstem insult
      - (d) Noxious or hypoxic atmosphere
      - (e) Renal failure
    - (3) Multiple symptoms
      - (a) Altered response
      - (b) Respiratory rate changes (up or down)
- XIV. Supplemental oxygen therapy
  - 1. Rationale
    - a. Enriched O<sub>2</sub> atmosphere increases oxygen to cells
    - b. Increasing available O<sub>2</sub> increases patient's ability to compensate
    - c. O<sub>2</sub> delivery method must be reassessed to determine adequacy and efficiency
  - 2. Oxygen source

- a. Compressed gas
    - (1) Oxygen compressed in gas form in an aluminum or steel tank
    - (2) Common sizes and volumes
      - (a) D 400L
      - (b) E 660L
      - (c) M 3450L
    - (3) O<sub>2</sub> delivery measured in liters/ min (LPM)
    - (4) Calculating tank life
      - (a) Tank pressure (psi) x 0.28 = volume
      - (b) Volume/ LPM = tank life in minutes
  - b. Liquid oxygen
    - (1) O<sub>2</sub> cooled to its aqueous state
      - (a) Converts to gaseous state when warmed
    - (2) Advantage
      - (a) Much larger volume of gaseous O<sub>2</sub> can be stored in aqueous state
    - (3) Disadvantage
      - (a) Units generally require upright storage
      - (b) Special requirements for large volume storage and cylinder transfer
3. Regulators
- a. High-pressure
    - (1) Attached to cylinder stem delivers cylinder gas under high pressure
    - (2) Used to transfer cylinder gas from tank to tank
  - b. Therapy regulators
    - (1) Attached to cylinder stem
    - (2) 50psi escape pressure is "stepped down" through regulator mechanism
    - (3) Subsequent delivery to patient is adjustable low pressure
4. Delivery devices
- a. Nasal cannula
    - (1) Nasally placed O<sub>2</sub> catheter for oxygen enrichment
    - (2) Optimal delivery: 40% at 6 L/ min
    - (3) Indications
      - (a) Low to moderate O<sub>2</sub> enrichment
      - (b) Long term O<sub>2</sub> maintenance therapy
    - (4) Contraindications
      - (a) Poor respiratory effort
      - (b) Severe hypoxia
      - (c) Apnea
      - (d) Mouth breathing
    - (5) Advantages
      - (a) Well tolerated
    - (6) Disadvantages
      - (a) Does not deliver high volume/ high concentration
  - b. Simple face mask
    - (1) Full airway enclosure with open side ports
      - (a) Room air is drawn through side ports on inspiration
      - (b) Diluting O<sub>2</sub> concentration
    - (2) Indications
      - (a) Delivery of moderate to high O<sub>2</sub> concentrations
      - (b) Range - 40-60% at 10 L/ min

- (3) Advantages
      - (a) Higher O<sub>2</sub> concentrations
    - (4) Disadvantages
      - (a) Delivery of volumes beyond 10 L/ min does not enhance O<sub>2</sub> concentration
    - (5) Special considerations
      - (a) Mask leak around face decreases O<sub>2</sub> concentration
  - c. Partial rebreather
    - (1) Mask vent ports covered by one-way disc
      - (a) Residual expired air mixed in mask and rebreathed
      - (b) Room air not entrained with inspiration
    - (2) Indications
    - (3) Contraindications
      - (a) Apnea
      - (b) Poor respiratory effort
    - (4) Advantages
      - (a) Inspired gas not mixed with room air
        - i) Higher O<sub>2</sub> concentrations attainable
      - (b) Disadvantages
        - i) Delivery of volumes beyond 10 L/ min does not enhance O<sub>2</sub> concentration
      - (c) Special considerations
        - i) Mask leak around face decreases O<sub>2</sub> concentration
  - d. Non-rebreather mask
    - (1) Mask side ports covered by one-way disc
    - (2) Reservoir bag attached
    - (3) Range: 80-95+% at 15 L/ min
    - (4) Indications
      - (a) Delivery of highest O<sub>2</sub> concentration
    - (5) Contraindications
      - (a) Apnea
      - (b) Poor respiratory effort
    - (6) Advantages
      - (a) Highest O<sub>2</sub> concentration
      - (b) Delivers high volume/ high O<sub>2</sub> enrichment
      - (c) Patient inhales enriched O<sub>2</sub> from reservoir bag rather than residual air
    - (7) Disadvantages
  - e. Venturi mask
    - (1) Mask with interchangeable adapters
      - (a) Adapters have port holes that entrain room air as O<sub>2</sub> passes
      - (b) Patient receives a highly specific concentration of O<sub>2</sub>
      - (c) Air is entrained by venturi principle
  - f. Small volume nebulizer
    - (1) Delivers aerosolized medication
    - (2) O<sub>2</sub> enters an aerosol chamber containing 3-5 ccs of fluid
    - (3) Pressurized O<sub>2</sub> mists fluid
5. Oxygen humidifiers
- a. Sterile water reservoir for humidifying O<sub>2</sub>
  - b. Good for long term O<sub>2</sub> administration
  - c. Desirable for croup/ Epiglottitis/ bronchiolitis



- 6. Tracheostomy, stoma, and tracheostomy tubes
  - a. Tracheostomy
    - (1) Surgical opening into trachea
      - (a) Done in operating room under controlled conditions
      - (b) A stoma located just superior to the suprasternal notch
  - b. Stoma
    - (1) Resultant orifice connecting trachea to outside air
    - (2) Patient now breathes through this surgical opening
  - c. Tracheostomy tube
    - (1) Plastic tube placed within tracheostomy site
    - (2) 15 mm connector for ventilator acceptance
- XV. Ventilation
  - 1. Mouth-to-mouth
    - a. Most basic form of ventilation
    - b. Indications
      - (1) Apnea from any mechanism when other ventilation devices are not available
    - c. Contraindications
      - (1) Awake patients
      - (2) Communicable disease risk limitations
    - d. Advantages
      - (1) No special equipment required
      - (2) Delivers excellent tidal volume
      - (3) Delivers adequate oxygen
    - e. Disadvantages
      - (1) Psychological barriers from
        - (a) Sanitary issues
        - (b) Communicable disease issues
          - i) Direct blood/ body fluid contact
          - ii) Unknown communicable disease risks at time of event
    - f. Complications
      - (1) Hyperinflation of patient's lungs
      - (2) Gastric distension
      - (3) Blood/ body fluid contact manifestation
      - (4) Hyperventilation of rescuer
  - 2. Mouth-to-nose
    - a. Ventilating through nose rather than mouth
    - b. Indications
      - (1) Apnea from any mechanism
    - c. Contraindications
      - (1) Awake patients
    - d. Advantages
      - (1) No special equipment required
    - e. Disadvantages
      - (1) Direct blood/ body fluid contact
      - (2) Psychological limitations of rescuer
    - f. Complications
      - (1) Hyperinflation of patient's lungs
      - (2) Gastric distension

- (3) Blood/ body fluid manifestation
  - (4) Hyperventilation of rescuer
- 3. Mouth-to-mask
  - a. Adjunct to mouth-to-mouth ventilation
  - b. Indications
    - (1) Apnea from any mechanism
  - c. Contraindications
    - (1) Awake patients
  - d. Advantages
    - (1) Physical barrier between rescuer and patient blood/ body fluids
    - (2) One-way valve to prevent blood/ body fluid splash to rescuer
    - (3) May be easier to obtain face seal
  - e. Disadvantages
    - (1) Useful only if readily available
  - f. Complications
    - (1) Hyperinflation of patient's lungs
    - (2) Hyperventilation of rescuer
    - (3) Gastric distention
  - g. Method for use
    - (1) Position head by appropriate method
    - (2) Position and seal mask over mouth and nose
    - (3) Ventilate as appropriate
- 4. One person bag-valve-mask
  - a. Fixed volume self inflating bag can deliver adequate tidal volumes and O<sub>2</sub> enrichment
  - b. Indications
    - (1) Apnea from any mechanism
    - (2) Unsatisfactory respiratory effort
  - c. Contraindications
    - (1) Awake, intolerant patients
  - d. Advantages
    - (1) Excellent blood/ body fluid barrier
    - (2) Good tidal volumes
    - (3) Oxygen enrichment
    - (4) Rescuer can ventilate for extended periods without fatigue
  - e. Disadvantages
    - (1) Difficult skill to master
    - (2) Mask seal may be difficult to obtain and maintain
    - (3) Tidal volume delivered is dependent on mask seal integrity
  - f. Complications
    - (1) Inadequate tidal volume delivery with
      - (a) Poor technique
      - (b) Poor mask seal
      - (c) Gastric distention
  - g. Method for use
    - (1) Position appropriately
    - (2) Choose proper mask size - seats from bridge of nose to chin
    - (3) Position, spread/ mold/ seal mask
    - (4) Hold mask in place
    - (5) Squeeze bag completely over 1.5 to 2 seconds for adults

- (6) Avoid overinflation
    - (7) Reinflate completely over several seconds
  - h. Special considerations
    - (1) Medical
      - (a) Observe for
        - i) Gastric distension
        - ii) Changes in compliance of bag with ventilation
        - iii) Improvement or deterioration of ventilation status ( i.e., color change, responsiveness, air leak around mask)
    - (2) Trauma
      - (a) Very difficult to perform with cervical spine immobilization in place
- 5. Two person bag-valve-mask ventilation method
  - a. Most efficient method
  - b. Indications
    - (1) Bag-valve-mask ventilation on any patient
      - (a) Especially useful for cervical spine immobilized patients
      - (b) Difficulty obtaining or maintaining adequate mask seal
  - c. Contraindications
    - (1) Awake, intolerant patients
  - d. Advantages
    - (1) Superior mask seal
    - (2) Superior volume delivery
  - e. Disadvantages
    - (1) Requires extra personnel
  - f. Complications
    - (1) Hyperinflation of patient's lungs
    - (2) Gastric distension
  - g. Method for use
    - (1) First rescuer maintains mask seal by appropriate method
    - (2) Second rescuer squeezes bag
  - h. Special considerations
    - (1) Observe chest movement
    - (2) Avoid overinflation
    - (3) Monitor lung compliance with ventilations
- 6. Three person bag-valve-mask ventilation
  - a. Indications
    - (1) Bag-valve-mask ventilation on any patient
      - (a) Especially useful for cervical spine immobilized patients
      - (b) Difficulty obtaining or maintaining adequate mask seal
  - b. Contraindications
    - (1) Awake, intolerant patients
  - c. Advantages
    - (1) Superior mask seal
    - (2) Superior volume density
  - d. Disadvantages
    - (1) Requires extra personnel
    - (2) "Crowded" around airway
  - e. Complications
    - (1) Hyperinflation of patient's lungs

- (2) Gastric distension
  - f. Method for use
    - (1) First rescuer maintains mask seal by appropriate method
    - (2) Second rescuer holds mask in place
    - (3) Third rescuer squeezes bag and monitors compliance
  - g. Special considerations
    - (1) Avoid overinflation
    - (2) Monitor lung compliance with ventilations
- 7. Flow-restricted, oxygen-powered ventilation devices
  - a. The valve opening pressure at the cardiac sphincter is approx 30 cm H<sub>2</sub>O
  - b. These devices operate at or below 30 cm H<sub>2</sub>O to prevent gastric distension
  - c. Indications
    - (1) Delivery of high volume/ high concentration of O<sub>2</sub> (1 L/ sec)
    - (2) Awake compliant patients
    - (3) Unconscious patient with caution
  - d. Contraindications
    - (1) Noncompliant patients
    - (2) Poor tidal volume
    - (3) Small children
  - e. Advantages
    - (1) Self administered
    - (2) Delivers high volume/ high concentration O<sub>2</sub>
    - (3) O<sub>2</sub> delivered in response to inspiratory effort (no O<sub>2</sub> wasting)
    - (4) O<sub>2</sub> volume delivery is regulated by inspiratory effort minimizing overinflation risk
    - (5) O<sub>2</sub> volume delivery is also restricted to less than 30 cm H<sub>2</sub>O
  - f. Disadvantages
    - (1) Cannot monitor lung compliance
    - (2) Requires O<sub>2</sub> source
  - g. Complications
    - (1) Gastric distension
    - (2) Barotrauma
  - h. Method
    - (1) Mask is held manually in place
    - (2) Negative pressure upon inspiration triggers O<sub>2</sub> delivery or medic triggers release button
    - (3) Patient is monitored for adequate tidal volume and oxygenation
- 8. Automatic transport ventilators
  - a. Volume/ rate controlled
  - b. Indications
    - (1) Extended ventilation of intubated patients
    - (2) In situations in which a BVM is used
    - (3) Can be used during CPR
  - c. Contraindications
    - (1) Awake patients
    - (2) Obstructed airway
    - (3) Increased airway resistance
      - (a) Pneumothorax (after needle decompression)
      - (b) Asthma
      - (c) Pulmonary edema
  - d. Advantages

- (1) Frees personnel to perform other tasks
    - (2) Lightweight
    - (3) Portable
    - (4) Durable
    - (5) Mechanically simple
    - (6) Adjustable tidal volume
    - (7) Adjustable rate
    - (8) Adapts to portable O<sub>2</sub> tank
  - e. Disadvantages
    - (1) Cannot detect tube displacement
    - (2) Does not detect increasing airway resistance
    - (3) Difficult to secure
    - (4) Dependent on O<sub>2</sub> tank pressure
- 9. Cricoid pressure - Sellick's maneuver
  - a. Pressure on cricoid Ring
  - b. Occludes esophagus
  - c. Facilitates intubation by moving the larynx posteriorly
  - d. Helps to prevent passive emesis
  - e. Can help minimize gastric distension during bag-valve-mask ventilation
  - f. Indications
    - (1) Vomiting is imminent or occurring
    - (2) Patient cannot protect own airway
  - g. Contraindications
    - (1) Use with caution in cervical spine injury
  - h. Advantages
    - (1) Noninvasive
    - (2) Protects from aspiration as long as pressure is maintained
  - i. Disadvantages
    - (1) May have extreme emesis if pressure is removed
    - (2) Second rescuer required for bag-valve-mask ventilation
    - (3) May further compromise injured cervical spine
  - j. Complications
    - (1) Laryngeal trauma with excessive force
    - (2) Esophageal rupture from unrelieved high gastric pressures
    - (3) Excessive pressure may obstruct the trachea in small children
  - k. Method
    - (1) Locate the anterior aspect of the cricoid ring
    - (2) Apply firm, posterior pressure
    - (3) Maintain pressure until the airway is secured with an endotracheal tube
- 10. Artificial ventilation of the pediatric patient
  - a. Flat nasal bridge makes achieving mask seal more difficult
  - b. Compressing mask against face to improve mask seal results in obstruction
  - c. Mask seal best achieved with jaw displacement (two person bag-valve-mask)
  - d. Bag-valve-mask ventilation
    - (1) Bag size
      - (a) Full-term neonates and infants - minimum of 450 ml tidal volume (pediatric BVM)
      - (b) Children up to eight years of age - pediatric BVM preferred but adult-sized BVM (1500 ml) may be used
      - (c) Children over eight years of age require adult-sized BVM for adequate ventilation

- (d) Proper mask fit
    - (e) Length based resuscitation tape
    - (f) Bridge of nose to cleft of chin
  - (2) Proper mask position and seal (EC-clamp)
    - (a) Place mask over mouth and nose; avoid compressing the eyes
    - (b) Using one hand, place thumb on mask at apex and index finger on mask at chin (C-grip)
    - (c) With gentle pressure, push down on mask to establish adequate seal
    - (d) Maintain airway by lifting bony prominence of chin with remaining fingers forming an "E"; avoid placing pressure on the soft area under chin
    - (e) May use one or two rescuer technique
  - (3) Ventilate according to current standards
  - (4) Obtain chest rise with each breath
    - (a) Begin ventilation and say "squeeze"; provide just enough volume to initiate chest rise; DO NOT OVERVENTILATE
  - (5) Allow adequate time for exhalation
    - (a) Begin releasing the bag and say "release, release"
  - (6) Continue ventilations using "squeeze, release, release" method
  - (7) Assess BVM ventilation
    - (a) Look for adequate chest rise
    - (b) Listen for lung sounds at third intercostal space, midaxillary line
    - (c) Assess for improvement in color and/ or heart rate
  - (8) Apply cricoid pressure to minimize gastric inflation and passive regurgitation
    - (a) Locate cricoid ring by palpating the trachea for a prominent horizontal band inferior to the thyroid cartilage and cricothyroid membrane
    - (b) Apply gentle downward pressure using one fingertip in infants and the thumb and index finger in children
    - (c) Avoid excessive pressure as it may produce tracheal compression and obstruction in infants
- 11. Ventilation of stoma patients
  - a. Mouth-to-stoma
    - (1) Locate stoma site and expose
    - (2) Pocket mask to stoma preferred
      - (a) Seal around stoma site, check for adequate ventilation
      - (b) Seal mouth and nose if air leak evident
  - b. Bag-valve-mask to stoma
    - (1) Locate stoma site and expose
    - (2) Seal around stoma site, check for adequate ventilation
    - (3) Seal mouth and nose if air leak evident
- XVI. Airway obstructions
  - 1. Causes
    - a. Tongue
    - b. Foreign body
    - c. Laryngeal spasm
    - d. Laryngeal edema
    - e. Trauma
  - 2. Classifications/ assessment
    - a. Complete obstruction

- b. Partial obstruction
    - (1) With good air exchange
    - (2) With poor air exchange
  - 3. Management
    - a. Heimlich maneuver
    - b. Finger sweep
    - c. Chest thrusts
    - d. Suctioning
    - e. Direct laryngoscopy for the removal of foreign body in airway obstruction
      - (1) If patient is unconscious and you are unable to ventilate and BLS methods fail
        - (a) Insert laryngoscope blade into patient's mouth
        - (b) If foreign body is visualized carefully and deliberately remove foreign body with Magill forceps
    - f. Intubation
- XVII. Suctioning
- 1. Suction devices
    - a. Hand-powered suction devices
      - (1) Advantages
        - (a) Lightweight
        - (b) Portable
        - (c) Mechanically simple
        - (d) Inexpensive
      - (2) Disadvantages
        - (a) Limited volume
        - (b) Manually powered
        - (c) Fluid contact components not disposable
    - b. Oxygen-powered portable suction devices
      - (1) Advantages
        - (a) Lightweight
        - (b) Small in size
      - (2) Disadvantages
        - (a) Limited suctioning power
        - (b) Uses a lot of oxygen for limited suctioning power
    - c. Battery-operated portable suction devices
      - (1) Advantages
        - (a) Lightweight
        - (b) Portable
        - (c) Excellent suction power
        - (d) May "field" troubleshoot most problems
      - (2) Disadvantages
        - (a) More complicated mechanics
        - (b) May lose battery integrity over time
        - (c) Some fluid contact components not disposable
    - d. Mounted vacuum-powered suction devices
      - (1) Advantages
        - (a) Extremely strong vacuum
        - (b) Adjustable vacuum power
        - (c) Fluid contact components disposable

- (2) Disadvantages
    - (a) Non-portable
    - (b) Cannot "field service" or substitute power source
- 2. Suctioning catheters
  - a. Hard or rigid catheters
    - (1) "Yankauer" or "tonsil tip"
    - (2) Suction large volumes of fluid rapidly
    - (3) Standard size
    - (4) Various sizes
  - b. Soft catheters
    - (1) Can be placed in oropharynx, nasopharynx, or down endotracheal tube
    - (2) Various sizes
    - (3) Smaller inside diameter than hard tip catheters
    - (4) Suction tubing without catheter (facilitates suctioning of large debris)
- 3. Suctioning the upper airway
  - a. Prevention of aspiration critical
    - (1) Mortality increases significantly if aspiration occurs
    - (2) Preoxygenate if possible
    - (3) Hyperoxygenate after suctioning
  - b. Description
    - (1) Soft tip catheters must be prelubricated
    - (2) Place catheter
    - (3) Suction during extraction of catheter
    - (4) Suction to clear the airway
    - (5) Reevaluate patency of the airway
    - (6) Ventilate and oxygenate
- 4. Tracheobronchial suctioning
  - a. Use sterile technique, if possible
  - b. Preoxygenation essential
  - c. Description
    - (1) Pre-lubricate soft tip catheter
    - (2) Hyperoxygenate
      - (a) May be necessary to inject 3 to 5 ccs of sterile water down endotracheal tube to loosen secretions
    - (3) Gently insert catheter until resistance is felt
    - (4) Suction upon extraction of catheter
    - (5) Do not exceed 15 seconds
    - (6) Ventilate and oxygenate
- 5. Gastric distention
  - a. Air becomes trapped in the stomach
  - b. Very common when ventilating non-intubated patients
  - c. Stomach diameter increases
  - d. Pushes against diaphragm
  - e. Interferes with lung expansion
  - f. Abdomen becomes increasingly distended
  - g. Resistance to bag-valve-mask ventilation
  - h. Management
    - (1) Non-invasive
      - (a) May be reduced by increasing bag-valve-mask ventilation time



- i) Adults - 1.5 to 2 seconds
    - ii) Pediatrics - 1 to 1.5 seconds
  - (b) Prepare for large volume suction
  - (c) Position patient left lateral
  - (d) Slowly apply pressure to epigastric region
  - (e) Suction as necessary
- (2) Gastric tubes
- (a) Tube placed in the stomach for gastric decompression and/ or emesis control
  - (b) Nasogastric decompression
    - i) Indications
      - a) Threat of aspiration
      - b) Need for lavage
    - ii) Contraindications
      - a) Extreme caution in esophageal disease or esophageal trauma
      - b) Facial trauma (caution)
      - c) Esophageal obstruction
    - iii) Advantages
      - a) Tolerated by awake patients
      - b) Does not interfere with intubation
      - c) Mitigates recurrent gastric distension
      - d) Mitigates nausea
      - e) Patient can still talk
    - iv) Disadvantages
      - a) Uncomfortable for patient
      - b) May cause patient to vomit during placement even if gag is suppressed
      - c) Interferes with BVM seal
    - v) Complications
      - a) Nasal, esophageal or gastric trauma from poor technique
      - b) Endotracheal placement
      - c) Supragastric placement
      - d) Tube obstruction
    - vi) Method
      - a) Prepare patient
        - b) Head neutral
        - c) Oxygenate
        - d) Suppress gag with topical anaesthetic or IV lidocaine
        - e) Anesthetize and dilate nares
      - f) Lubricate tube
      - g) Advance gently along nasal floor
        - h) Encourage patient to swallow or drink to facilitate passage
      - i) Advance into stomach
      - j) Confirm placement
        - k) Auscultate while injecting 30-50 ccs of air
        - l) Note gastric contents through tube
        - m) No reflux around tube
      - n) Secure in place
  - (c) Orogastric decompression

- i) Indications
  - a) Same parameters as NG
  - b) Generally preferred for unconscious patients
- ii) Contraindications
  - a) Same parameters as NG
- iii) Advantages
  - a) May use larger tubes
  - b) May lavage more aggressively
  - c) Safe to pass in facial fracture
  - d) Avoids nasopharynx
- iv) Disadvantages
  - a) May interfere with visualization during Intubation
- v) Method
  - a) Neutral or flexed head position
  - b) Introduce tube down midline
  - c) Procedure same as NG
- vi) Complications
  - a) Same as NG
  - b) Patient may bite tube

XVIII. Airway management

1. Manual maneuvers

- a. Head-tilt/ chin-lift maneuver
  - (1) Technique
    - (a) Tilt head back
    - (b) Lift chin forward
    - (c) Open mouth
  - (2) Indications
    - (a) Unresponsive patients who
      - i) Do not have mechanism for c-spine injury
      - ii) Unable to protect their own airway
  - (3) Contraindications
    - i) Awake patients
    - ii) Possible c-spine injury
  - (4) Advantages
    - (a) No equipment required
    - (b) Simple
    - (c) Safe
    - (d) Non-invasive
  - (5) Disadvantages
    - (a) Head tilt hazardous to c-spine injured patients
    - (b) Does not protect from aspiration
- b. Jaw-thrust without head-tilt maneuver
  - (1) Technique
    - (a) Head is maintained neutral
    - (b) Jaw is displaced forward
    - (c) Lift by grasping under chin and behind teeth
    - (d) Mouth opened
  - (2) Indications

- (a) Patients who are
        - i) Unresponsive
        - ii) Unable to protect their own airway
        - iii) May have c-spine injury
    - (3) Contraindications
      - (a) Responsive patients
      - (b) Resistance to opening mouth
    - (4) Advantages
      - (a) May be used in c-spine injury
      - (b) May be performed with cervical collar in place
      - (c) Does not require special equipment
    - (5) Disadvantages
      - (a) Cannot maintain if patient becomes responsive or combative
      - (b) Difficult to maintain for extended period
      - (c) Very difficult to use in conjunction with bag-valve-mask ventilation
      - (d) Thumb must remain in patient's mouth in order to maintain displacement
      - (e) Separate rescuer required to perform bag-valve-mask ventilation
      - (f) Does not protect against aspiration
  - c. Modified jaw-thrust maneuver
    - (1) Technique
      - (a) Head maintained neutral
      - (b) Jaw is displaced forward at mandibular angle
    - (2) Indications
      - (a) Unresponsive
      - (b) Cervical spine Injury
      - (c) Unable to protect own airway
      - (d) Resistance to opening mouth
    - (3) Contraindications
      - (a) Awake patients
    - (4) Advantages
      - (a) Non-invasive
      - (b) Requires no special equipment
      - (c) May be used with cervical collar in place
    - (5) Disadvantages
      - (a) Difficult to maintain
      - (b) Requires second rescuer for bag-valve-mask ventilation
      - (c) Does not protect against aspiration
2. Nasal airway
  - a. Soft rubber with beveled tip
    - (1) Distal tip rests in hypopharynx
    - (2) For adults, length measured from nostril to earlobe
    - (3) Diameter roughly equal to patient's little finger
  - b. Indications
    - (1) Unconscious patients
    - (2) Altered response patients with suppressed gag reflex
  - c. Contraindications
    - (1) Patient intolerance
    - (2) Caution in presence of facial fracture or skull fracture
  - d. Advantages

- (1) Can be suctioned through
    - (2) Provides patent airway
    - (3) Can be tolerated by awake patients
    - (4) Can be safely placed "blindly"
    - (5) Does not require mouth to be open
  - e. Disadvantages
    - (1) Poor technique may result in severe bleeding
      - (a) Resulting epistaxis may be extremely difficult to control
    - (2) Does not protect from aspiration
  - f. Placement
    - (1) Determine correct length and diameter
    - (2) Lubricate nasal airway
    - (3) With bevel towards septum, insert gently along the nasal floor parallel to the mouth
    - (4) Do not force
    - (5) Measurement from corner of the mouth to the jaw angle rather than tip of the ear
    - (6) Too long airway causes airway obstruction
- 3. Oral airway
  - a. Hard plastic airway designed to prevent the tongue from obstructing glottis
  - b. Indications
    - (1) Unconscious patients
    - (2) Absent gag reflex
  - c. Contraindications
    - (1) Conscious patients
  - d. Advantages
    - (1) Non-invasive
    - (2) Easily placed
    - (3) Prevents blockage of glottis by tongue
  - e. Disadvantages
    - (1) Does not prevent aspiration
    - (2) Unexpected gag may produce vomiting
  - f. Complications
    - (1) Unexpected gag may produce vomiting
    - (2) Pharyngeal or dental trauma with poor technique
  - g. Placement
    - (1) Open mouth
    - (2) Remove visible obstructions
    - (3) Place with distal tip toward glottis using tongue depressor as adjunct
    - (4) Alternate method - place airway with distal tip toward palate and rotate into place
  - h. Pediatrics
    - (1) Place with tongue depressor
    - (2) Place with tip toward tongue, not palate
- 4. Endotracheal tube
  - a. Tube passed into the trachea in order to provide externally controlled breathing through a BVM or ventilator
    - (1) Sizes
      - (a) 2.5-9.0 mm inside diameter (id)
      - (b) Length 12-32 cm
    - (2) Types
      - (a) Cuffed 5.0-9.0

- i) Proximal end 15 mm adapter
    - ii) Proximal end inflation port with pilot balloon
    - iii) Cm markings along length
    - iv) Distal end beveled tip
    - v) Distal end balloon cuff
  - (b) Uncuffed 2.5-4.5
    - i) Proximal end 15 mm adapter
    - ii) Distal end bevel tip
    - iii) Distal end depth markings
    - iv) No balloon cuff or pilot balloon
- b. Indications
  - (1) Present or impending respiratory failure
  - (2) Apnea
  - (3) Failure to protect own airway
- c. Contraindications
- d. Advantages
  - (1) Provides a secure airway
  - (2) Protects against aspiration
  - (3) Route for medication
- e. Disadvantages
  - (1) Special equipment needed
  - (2) Bypasses physiologic function of upper airway
    - (a) Warming
    - (b) Filtering
    - (c) Humidifying
- f. Complications
  - (1) Bleeding
  - (2) Laryngeal swelling
  - (3) Laryngospasm
  - (4) Vocal cord damage
  - (5) Mucosal necrosis
  - (6) Barotrauma
- g. Techniques of insertion
  - (1) Orotracheal intubation by direct laryngoscopy
    - (a) Directly visualizing the passage of an ET tube into the trachea
    - (b) Indications
      - i) Apnea
      - ii) Hypoxia
      - iii) Poor respiratory effort
      - iv) Suppression or absence of gag reflex
    - (c) Contraindications
      - i) Caution in unsuppressed gag reflex
    - (d) Advantages
      - i) Direct visualization of anatomy and tube placement
      - ii) Ideal method for confirming placement
      - iii) May be performed in breathing and apneic patients
    - (e) Disadvantages
      - i) Requires special equipment
    - (f) Complications

- 
- 
- i) Dental trauma
      - ii) Laryngeal trauma
      - iii) Misplacement
        - a) Right mainstem
        - b) Esophageal
    - (g) Equipment
      - i) Laryngoscope
        - a) Device used to visualize glottis during endotracheal intubation
        - b) Battery pack/ handle with interchangeable blades
        - c) Blade types
          - d) Straight (Miller) lifts epiglottis
          - e) Curved (MacIntosh) lifts epiglottis by fitting into vallecula
      - ii) 10 cc syringe to inflate/ deflate balloon cuff
      - iii) Water soluble lubricant to lubricate endotracheal tube, promote ease of passage, and decrease trauma
      - iv) Stylet - semi-rigid wire for molding and maintaining tube shape
      - v) Securing device
        - a) Tape
        - b) Commercially available endotracheal tube holder
      - vi) Suction
      - vii) Body substance precautions
        - a) Gloves
        - b) Mask
        - c) Eyewear or faceshield
  - h. Endotracheal intubation technique
    - (1) Medical patient
      - (a) Orotracheal intubation by direct laryngoscopy
      - (b) Place patient supine in sniffing position to facilitate visualization
      - (c) Method
        - i) Position used when the potential for c-spine injury does not exist
          - a) Sniffing position
          - b) Optimal hyperextension of head with elevation of occiput
          - c) Brings the axes of the mouth, the pharynx, and the trachea into alignment
        - ii) When potential for c-spine injury exists head is held firmly in neutral position during intubation
        - iii) Ensure optimal oxygenation and ventilation with 100% O<sub>2</sub>
        - iv) Ensure all equipment is prepared
          - a) Lubricated tube with stylet in place
          - b) Best position is "hockey stick"
          - c) Bend directly behind balloon cuff
        - d) Working laryngoscope
          - e) Blade locks securely in place
          - f) Light is bright and steady (unpleasant to look at)
        - g) Test cuff by inflating and then deflating
        - v) Ideally, hyperoxygenate patient for 30 seconds to 1 minute
        - vi) Insert laryngoscope blade
          - a) Gently insert to hypopharynx
          - b) Lift tongue and jaw with firm, steady pressure

- c) Avoid fulcrum against teeth
  - vii) Identify vocal cords
  - viii) Gently pass ET tube until observe passage of balloon cuff past cords
  - ix) Remove stylet
  - x) Inflate balloon cuff
  - xi) Ventilate patient
  - xii) Confirm placement with multiple methods
  - xiii) Reconfirm placement with major patient movement or head movement
- (2) Nasotracheal intubation
  - (a) Passage of ET tube through nasopharynx into trachea
  - (b) Indications
    - i) Breathing patients requiring intubation
  - (c) Contraindications
    - i) Caution with facial trauma
    - ii) Caution with deviated septum
  - (d) Advantages
    - i) Does not require laryngoscope
    - ii) Does not require sniffing position
    - iii) More easily secured
    - iv) Patient cannot bite tube
  - (e) Disadvantages
    - i) "Blind" technique
    - ii) Can only be performed on breathing patients
  - (f) Method
    - i) Patient's head is placed in neutral position
    - ii) Standard pre-intubation precautions
      - a) Suction
      - b) Oxygenation
      - c) Equipment preparation
    - iii) Preform tube
      - a) Bend into circle while preparing patient
      - b) Use endotrol tube
        - c) Endotracheal tube with attached line that adjusts direction of the distal tip (substitutes for stylet)
    - iv) Hyperoxygenate
    - v) Gently insert lubricated tube
      - a) Bevel towards septum
      - b) Along nasal floor
      - c) Through largest or most compliant nostril
    - vi) Advance tube until loudest exchange of air is heard (approximately 15cm)
      - a) May need to slightly rotate tube
    - vii) Advance tube through vocal cords on inspiration
    - viii) Inflate cuff
    - ix) Confirm placement
    - x) Secure tube
- (3) Digital intubation
  - (a) Direct palpation of glottic structures to intubate trachea
  - (b) Indications
    - i) Apnea

- ii) Confined space
    - iii) Inability to directly visualize
  - (c) Contraindications
    - i) Breathing patient
    - ii) Present gag reflex
  - (d) Advantages
    - i) Does not require laryngoscope
    - ii) Does not require sniffing position
    - iii) May be passed through fluid obstructions
  - (e) Disadvantages
    - i) Semi-blind technique
    - ii) May only be done on apneic patients
  - (f) Method
    - i) Pre-intubation precautions
    - ii) Open mouth
      - a) Extending tongue with gauze will facilitate palpation of glottis
    - iii) Palpate and lift epiglottis
    - iv) Palpate arytenoid cartilage
    - v) Pass tube between epiglottis and arytenoids
    - vi) Inflate balloon cuff
    - vii) Confirm placement
    - viii) Secure tube
- (4) Transillumination techniques (lighted stylet)
  - (a) Use of a lighted stylet to transilluminate the glottis and facilitate intubation
  - (b) Indications
    - i) Inability to directly visualize glottis
    - ii) Cervical spine injury
  - (c) Contraindications
    - i) Present gag reflex
    - ii) Airway obstruction
  - (d) Advantages
    - i) Minimal manipulation of cervical spine
    - ii) Adds visual parameter to blind technique
  - (e) Disadvantages
    - i) Difficult in bright light
  - (f) Method
    - i) Pre-intubation precautions
    - ii) Place patient in neutral position
    - iii) Bend tube into "J"
    - iv) Turn on stylet
      - a) Insert midline into pharynx
    - v) Observe for focused midline glow
    - vi) Advance additional 1-2 cm
    - vii) Remove stylet
    - viii) Inflate balloon cuff
    - ix) Confirm placement
    - x) Secure tube
- i. Confirming placement
  - (1) Methods



- 
- 
- (a) Direct re-visualization
      - i) Re-visualize glottis
      - ii) Note tube depth
        - a) Average tube depth in males is 22 cm at the teeth
        - b) Average tube depth in women is 21 cm
    - (b) Note condensation in the tube
    - (c) Auscultation
      - i) Epigastric area
        - a) Air entry into stomach indicates esophageal placement
      - ii) Bilateral bases
        - a) Equal volume and expansion
      - iii) Apices
        - a) Equal volume
      - iv) Unequal or absent breath sounds indicate
        - a) Esophageal placement
        - b) Right mainstem placement
        - c) Pneumothorax
        - d) Bronchial obstruction
    - (d) Palpation of balloon cuff at sternal notch by compressing pilot balloon
    - (e) Pulse oximetry
    - (f) Expired CO<sub>2</sub>
      - i) Measures presence of CO<sub>2</sub> in expired air
        - a) Colormetric
        - b) Digital
        - c) Digital/ waveform
    - (g) Bag-valve-mask ventilation compliance
      - i) Increased resistance to BVM compliance may indicate
        - a) Gastric distension
        - b) Esophageal placement
        - c) Tension pneumothorax
  - (2) Evidence of a misplaced tube regardless when it was last checked must be reconfirmed
  - (3) Confirmation must be performed
    - (a) By multiple methods
    - (b) Immediately after tube placement
    - (c) After any major move
    - (d) After manipulation of neck (manipulation of neck may displace tube up to 5 cm)
  - j. Corrective measures
    - (1) Esophageal placement
      - (a) Ready to vigorously suction as needed
      - (b) Likelihood of emesis is increased especially if gastric distension is present
      - (c) Ideally preoxygenate prior to reintubation
      - (d) Misplaced tube may be removed after proper tracheal placement is confirmed or it may be removed beforehand provided diligent and vigorous airway suctioning is ready
    - (2) Right mainstem placement
      - (a) Loosen or remove securing device
      - (b) Deflate balloon cuff
      - (c) While ventilation continues, SLOWLY retract tube while simultaneously listening for breath sounds over left chest

- (d) STOP as soon as breath sounds are heard in left chest
  - (e) Note tube depth
  - (f) Reinflate balloon cuff
  - (g) Secure tube
- k. Securing the tube
  - (1) As critical as the intubation itself
  - (2) Multiple methods and products available
  - (3) Adjuncts include
    - (a) Securing to maxilla rather than mandible
    - (b) Tincture of benzoin to facilitate tape adhesion
- l. Field extubation
  - (1) Generally, the only reason to field extubate is the patient is unreasonably intolerant of the tube
  - (2) Awake patients are at high risk of laryngospasm immediately following extubation
  - (3) There may be a problem re-inducing and re-intubating a laryngospastic patient
  - (4) Indications
    - (a) Able to protect and maintain airway
    - (b) Risks for need to reintubate significantly reduce
    - (c) Must not be sedated
  - (5) Contraindications
    - (a) Any risk of recurrence of respiratory failure
  - (6) Complications
    - (a) Highest risk of recurrence of laryngospasm is immediately post extubation
    - (b) Respiratory distress or failure may return necessitating re-intubation
  - (7) Method
    - (a) Ensure oxygenation
    - (b) Intubation equipment and suction immediately available
    - (c) Confirm patient responsiveness
    - (d) Suction oropharynx
    - (e) Deflate cuff
    - (f) Remove upon cough or expiration
  - (8) Special considerations
    - (a) Need for field extubation is extremely rare
    - (b) Intolerance of ET tube evidenced by gag reflex should be addressed by increasing sedation rather than removing tube
- m. Pediatric endotracheal intubation
  - (1) Laryngoscope and size appropriate blades
    - (a) Straight blades are preferred
    - (b) General guidelines
      - i) Premature infant - 0 straight
      - ii) Full-term infant to one year of age - 1 straight
      - iii) Two years of age to adolescent - 2 straight
      - iv) Adolescent and above - 3 straight or curved
  - (2) Appropriate size endotracheal tube
    - (a) Formula =  $(16 + \text{age in years}) \div 4$
    - (b) Anatomical clues
    - (c) General guidelines
      - i) Premature infant - 2.5 to 3.0 uncuffed
      - ii) Full-term infant - 3.0 to 3.5 uncuffed

- 
- 
- iii) Infant to one year of age - 3.5 to 4.0 uncuffed
  - iv) Toddler - 4.0 to 5.0 uncuffed
  - v) Preschool - 5.0 to 5.5 uncuffed
  - vi) School age - 5.5 to 6.5 uncuffed
  - vii) Adolescent - 7.0 to 8.0 cuffed
  - (d) Depth of insertion
    - i) 2-3 cm below the vocal cords
      - a) Uncuffed - place the black glottic marker of the tube at the level of the vocal cords
      - b) Cuffed - insert until the cuff is just below the vocal cords
    - ii) 3 x inside diameter - 1
    - iii) General guidelines
      - a) Premature infant - 8 cm
      - b) Full-term infant - 8 to 9.5 cm
      - c) Infant to one year of age - 9.5 to 11 cm
      - d) Toddler - 11 to 12.5 cm
      - e) Preschool - 12.5 to 14 cm
      - f) School age - 14 to 20 cm
      - g) Adolescent - 20 to 23 cm
  - (e) Appropriate sized endotracheal tube stylet
  - (3) Endotracheal tube securing device
    - (a) Tape
    - (b) Commercial device
  - (4) Technique
    - (a) Separate parent/ guardian and patient
    - (b) Manually open airway
    - (c) Insert appropriate airway adjunct if needed
    - (d) Ventilate patient with 100% oxygen via age appropriate sized bag
    - (e) Place the patient's head in the sniffing position
    - (f) Pre-oxygenate the patient with 100% oxygen a minimum of 30 seconds
    - (g) Prepare all equipment
      - i) Lubricate endotracheal tube with sterile water/ saline or water-soluble gel
      - ii) Lubricate stylet if utilized
    - (h) Insert the laryngoscope to the right side of the mouth and sweep the tongue to the left side
    - (i) Lift tongue with firm, steady pressure
      - i) Avoid fulcrum against teeth or gums
    - (j) Use the tip of the blade to lift epiglottitis
    - (k) Identify the vocal cords
    - (l) Introduce the endotracheal tube to the right side of the mouth
    - (m) Pass the tube through the vocal cords to about 2-3 cm below the vocal cords
    - (n) Confirm proper tube placement
      - i) Observe for symmetrical chest expansion
      - ii) Auscultate for equal breath sounds over each lateral chest wall high in the axillae
      - iii) Absence of breath sounds over the abdomen
      - iv) Improved heart rate and color
      - v) If available, end-tidal carbon dioxide detector
    - (o) Secure tube noting placement of distance marker at teeth/ gums

- (p) Reconfirm tube placement
- 5. Multi-lumen airways
  - a. Pharyngo-tracheal lumen airway (PTL)
    - (1) An endotracheal tube encased in a large pharyngeal tube
    - (2) Designed to be passed blindly
    - (3) Dual ventilation ports provide means to ventilate regardless of whether the ET tube is placed in the esophagus or the trachea
    - (4) Indications
      - (a) Alternative airway control when conventional intubation procedures are not available or successful
    - (5) Advantages
      - (a) Can ventilate with tracheal or esophageal placement
      - (b) No facemask to seal
      - (c) No special equipment
      - (d) Does not require sniffing position
    - (6) Disadvantages
      - (a) Cannot be used in awake patients
      - (b) Adults only
      - (c) Pharyngeal balloon mitigates but does not eliminate aspiration risk
      - (d) Can only be passed orally
      - (e) Extremely difficult to intubate around
    - (7) Method
      - (a) Head neutral
      - (b) Pre-intubation precautions
      - (c) Insert at the midline using jaw-lift
      - (d) Ventilate through pharyngeal tube (green) first
        - i) Chest rise indicates ET tube is in esophagus
          - a) Inflate pharyngeal balloon and ventilate
        - ii) No chest rise indicates ET tube in trachea
          - a) Inflate ET tube balloon cuff
          - b) Ventilate through ET tube
    - (8) Complications
      - (a) Pharyngeal or esophageal trauma from poor technique
      - (b) Unrecognized displacement of ET tube into esophagus
      - (c) Displacement of pharyngeal balloon
    - (9) Special considerations
      - (a) Good assessment skills are essential to properly confirm placement
      - (b) Mis-identification of placement has been reported
      - (c) Reinforce multiple confirmation of placement techniques
  - b. Combitube
    - (1) Pharyngeal and endotracheal tube molded into a single unit
    - (2) Indications
      - (a) Alternative airway control when conventional intubation measures are unsuccessful or unavailable
    - (3) Contraindications
      - (a) Children too small for the tube
      - (b) Esophageal trauma or disease
      - (c) Caustic ingestion
    - (4) Advantages

- (a) Rapid insertion
  - (b) No special equipment
  - (c) Does not require sniffing position
- (5) Disadvantages
  - (a) Impossible to suction trachea when tube is in esophagus
  - (b) Adults only
  - (c) Unconscious only
  - (d) Very difficult to intubate around
- (6) Method
  - (a) Head - neutral position
  - (b) Pre-intubation precautions
  - (c) Insert with jaw-lift at midline
  - (d) Inflate pharyngeal cuff with 100 ccs of air
  - (e) Inflate distal cuff with 10-15 ccs of air
  - (f) Ventilate through longest tube first (pharyngeal)
    - i) Chest rise indicates esophageal placement of distal tip
    - ii) No chest rise indicates tracheal placement, switch ports and ventilate
- (7) Special considerations
  - (a) Good assessment skills are essential to confirm proper placement
  - (b) Mis-identification of placement has been reported
  - (c) Reinforce multiple confirmation techniques

**XIX. Pharmacological adjuncts to airway management and ventilation**

- 1. Sedation in emergency intubation
  - a. Sedatives are used in airway management to
    - (1) Reduce anxiety
    - (2) Induce amnesia
    - (3) Decrease the gag reflex
  - b. Indications
    - (1) Combative patients
    - (2) Patients who require aggressive airway management but who are too conscious to tolerate intubation
    - (3) Agitated patients
  - c. Contraindications
    - (1) Known sensitivity to the medications
  - d. Advantages
    - (1) Decreases anxiety
    - (2) Induces amnesia
  - e. Disadvantages
    - (1) Respiratory depression
    - (2) Vomiting/ aspiration
  - f. Pharmacology
    - (1) Decreases anxiety
    - (2) Increases patient compliance
    - (3) Often produces amnesia to procedure
    - (4) Enhances ease of intubation
    - (5) Types of medications used
      - (a) Haloperidol
      - (b) Barbiturates

- (c) Benzodiazepines
    - (d) Etomidate
    - (e) Narcotics
    - (f) Ketamine
  - g. Complications
    - (1) Airway compromise
    - (2) Regurgitation/ aspiration
    - (3) Loss of protective reflexes
    - (4) Sedating patient with tenuous airway may completely collapse what airway they have
  - h. [Method](#)
- 2. Neuromuscular blockade in emergency intubation
  - a. The use of neuromuscular blocking agents to induce skeletal muscle paralysis
  - b. The patient is much easier to intubate once paralyzed
  - c. Indications
    - (1) Combative patients who need to be intubated
  - d. Contraindications
    - (1) Absolute
      - (a) Inability to ventilate once paralyzed
    - (2) Relative
      - (a) Patients who will be difficult to ventilate (i.e. facial hair, etc)
      - (b) Patients who will be difficult to intubate (short necks, etc.)
  - e. Advantages
    - (1) Enables the paramedic to intubate some patients who need aggressive airway management (i.e. head injury, etc.) but may be otherwise uncooperative
  - f. Disadvantages
    - (1) Paralysis of the diaphragm/ apnea
    - (2) Inability of the patient to protect their own airway
  - g. Pharmacology
    - (1) Skeletal muscles contract in response to nerve stimulus
    - (2) Junction of muscle and nerve fiber is neuromuscular junction
    - (3) Acetylcholine (ACH) allows nerve impulse to cross neuromuscular junction
    - (4) Neuromuscular blockade relaxes muscle by impeding the action of ACH
    - (5) Does not provide sedation
    - (6) Types
      - (a) Depolarizing agents
        - i) Substitute themselves into neuromuscular junction
        - ii) May cause fasciculations (uncontrollable muscle twitching)
        - iii) Examples
          - a) Succinylcholine
          - b) Rapid onset/ short duration (90 seconds/ 5-10 minutes)
          - c) Use with caution in burns, crush, blunt trauma (hyperkalemia)
      - (b) Non-depolarizing agents
        - i) Block uptake of ACH into junction
        - ii) Do not cause fasciculations
        - iii) Examples
          - a) Vecuronium
          - b) Rapid onset - 2 minutes
          - c) Short duration - 45 minutes

- d) Pancuronium
    - e) Rapid onset - 3-5 minutes
    - f) Longer duration - 1 hour
  - h. Complications
    - (1) Inability to intubate
    - (2) Inability to ventilate
    - (3) Vomiting
    - (4) Airway compromise
  - i. [Method for rapid sequence intubation](#)
- XX. Translaryngeal cannula ventilation
  - 1. High volume/ high pressure ventilation of lungs through cannulation of trachea below the glottis
    - a. Oxygen delivery differs from other methods
    - b. Delivers a large volume of O<sub>2</sub> through a small port
    - c. Delivers a very high pressure to the lungs compared to other methods (50 psi versus less than 1 psi through a regulator)
  - 2. Indications
    - a. Apnea
    - b. Delayed or inability to ventilate the patient by other means
  - 3. Contraindications
    - a. Total airway obstruction (both inspiratory and expiratory)
    - b. Equipment not immediately available
  - 4. Advantages
    - a. Rapidly performed
    - b. Provides adequate ventilation when performed properly
    - c. Does not manipulate the cervical spine
    - d. Does not interfere with subsequent attempts to intubate
  - 5. Disadvantages
    - a. Requires jet ventilator
    - b. Expends high volumes of oxygen more rapidly
    - c. May not protect against aspiration
  - 6. Equipment
    - a. Large bore IV catheter (14-16 gauge)
    - b. 10 cc syringe
    - c. 3 ccs of water or saline (optional)
    - d. Oxygen source (50 psi)
    - e. Jet ventilator
  - 7. Method
    - a. Prepare equipment
    - b. Identify cricothyroid membrane
    - c. Insert needle with syringe midline through cricothyroid membrane at a slight angle towards sternum
    - d. Withdraw on syringe plunger until air is freely withdrawn (bubbles if fluid is in syringe)
    - e. Advance additional 1 cm
    - f. Hold needle steady, advance catheter to hub
    - g. Attach jet ventilator
    - h. Ventilate once per five seconds
      - (1) Exhalation is passive through the glottis
  - 8. Complications

- a. Bleeding
    - (1) From improper catheter placement
  - b. Subcutaneous emphysema
    - (1) From excessive air leak around catheter site or undetected laryngeal trauma
  - c. Airway obstruction
    - (1) Result of excessive bleeding or subcutaneous air which compresses trachea
  - d. Barotrauma
    - (1) Resulting from overinflation
  - e. Hypoventilation
- XXI. Cricothyrotomy
- 1. Surgical access to the airway through the cricothyroid membrane
  - 2. Indications
    - a. Total upper airway obstruction (epiglottitis, acute anaphylaxis, respiratory tract burns, etc.)
    - b. Massive facial trauma
    - c. Delayed or inability to intubate or ventilate the patient by other means
    - d. Contraindication to intubation
    - e. Posterior laceration of the tongue
    - f. Inability to open the mouth
  - 3. Contraindications
    - a. Inability to identify anatomical landmarks
    - b. Crush injury to the larynx
    - c. Tracheal transection
    - d. Underlying anatomical abnormality (trauma, tumor, subglottic stenosis, etc.)
  - 4. Advantages
    - a. Rapidly performed
    - b. Much faster and technically easier than tracheostomy
    - c. Does not manipulate the cervical spine
  - 5. Disadvantages
    - a. Difficult to perform in children
    - b. Difficult to perform on patients with short, muscular, or fat necks
  - 6. Equipment
    - a. Endotracheal or tracheostomy tube
    - b. Scalpel
    - c. Curved hemostats
    - d. Suction apparatus
  - 7. [Method](#)
  - 8. Complications
    - a. Incorrect tube placement/ false passage
    - b. Thyroid gland damage
    - c. Severe bleeding
    - d. Subcutaneous emphysema
    - e. Laryngeal nerve damage
- XXII. Special patient considerations
- 1. Patients with laryngectomies (stomas)
    - a. Mucous plug
      - (1) Laryngectomies possess less efficient cough
      - (2) Mucous commonly obstructs tubes



- (3) Tube may be removed/ cleaned and replaced
  - b. Stenosis
    - (1) Stoma spontaneously narrows
      - (a) Potentially life-threatening
      - (b) Soft tissue swelling decreases stoma diameter
    - (2) Trach tube is difficult or impossible to replace
    - (3) ET tube must be placed before total obstruction
  - c. Suctioning
    - (1) Must be done with extreme caution if laryngeal edema is suspected
    - (2) Procedure
      - (a) Preoxygenate
      - (b) Inject 3 cc sterile saline down trachea
      - (c) Instruct patient to exhale
      - (d) Insert suction catheter until resistance detected
      - (e) Instruct patient to cough or exhale
      - (f) Suction during withdrawal
  - d. Tube replacement
    - (1) Lubricate appropriately sized tracheostomy tube or ET tube (5.0 or larger)
    - (2) Instruct patient to exhale
    - (3) Gently insert tube about 1-2 cm beyond balloon cuff
    - (4) Inflate balloon cuff
    - (5) Confirm comfort, patency and proper placement
    - (6) Ensure false lumen was not created
- 2. Dental appliances
  - a. Dentures, partial plates, etc.
  - b. Best removed before intubation
- 3. Airway management considerations for patients with facial injuries
  - a. Facial injuries suggest the possibility of cervical spine injury
    - (1) In-line stabilization
      - (a) Trauma technique endotracheal intubation
  - b. Foreign body/ blood in oropharynx
    - (1) Suction airway
  - c. Inability to ventilate/ intubate orally
    - (1) Requires surgical intervention